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ELECTRICAL TERMS.

THE great inconvenience that has hitherto existed in the electrical world, from the use of different terms to express the same idea by different writers, is fast dying out, owing principally to the influence of the action of the British Association, and their excellent reports upon electrical standards. There are four chief ideas involved in the consideration of electrical phenomena. These are expressed generally by *Potential*, *Quantity*, *Resistance*, and *Current*. The first has well-nigh jostled out of existence the indefinite and ambiguous word *tension*, and, what was frequently used for it, *intensity*. The second expresses a definite and clear idea of the magnitude or amount of electricity present. The third, the reciprocal, or inverse of conductivity—a term so little used because so little wanted—admits of no ambiguity or indistinctness. But the fourth still labours under the difficulty of having its various stages of relative magnitude interpreted sometimes by intensity of current, sometimes by strength of current, and sometimes by quantity of current. The last term is that still greatly used by telegraph engineers; the middle term is that introduced by the British Association, and gradually creeping into very general use among practical electricians; while the first term is very prevalent among our professors, and particularly those of the "foreign" school. The great objection to the use of the term "intensity," to imply the magnitude of the ratio $\frac{E}{R}$, is that until very recently the term was employed very largely to imply the magnitude of E; or, in other words, the difference of potential that determined the current. It is still so used in most of our text-books, and thus the use of such a term for another purpose introduces a difficulty in the minds of students which is very difficult to eradicate. The ease with which a science is mastered depends very greatly on the clearness with which terms are defined and comprehended. In Ohm's law—

$$C = \frac{E}{R}$$

if intensity is sometimes used to express the value of C and sometimes that of E confusion and difficulty must arise. If we were suddenly to introduce an entire new nomenclature into electrical science, none having previously existed, we might probably, without inconvenience, express the value of a current, by the term intensity; but when this word intensity from time immemorial, has been used to express the value of one of the conditions that determine the current, and when we find it so used by Daniel, Faraday, Snow Harris, and all our leading authorities, it is asking too much to give it an entire new meaning. It would be the same as though a new mathematical school were to spring up, and to call that which our fathers called a tangent a sine. The only argument in favour of its use, is that "intensité" is in universal use in French works. We might, with equal propriety, call a cabbage a shoe (choux).

Sir W. Thomson, our greatest living authority on Electricity, who formerly occasionally used "intensity," has long since abandoned that term in favour of "strength;" and, generally, our practical electricians have now abandoned intensity and quantity, and only speak of the strength of the current to indicate how one current differs from another in magnitude.

THE HELIOGRAPH OF MR. MANCE.*

By C. BECKER.

THROUGH the general introduction of Electric Telegraphy, and the all but universal adoption of the Morse alphabet, it occurred to Mr. Mance—who has the advantage of a thorough knowledge of both, and the privilege, if it can be called one, of a long residence in a country with plenty of sunshine—to develope and improve the existing appliances into a system. His aim has been to produce an instrument which is very compact, very portable, easily set up, and easily worked. Although he was first in favour of larger instruments (which are still preferable for permanent stations), he is now convinced that an instrument of the size here shown is all that is requisite. The chief objection to the adoption of the sun-telegraph is, that we cannot command the sun to shine in the same manner that we can control a galvanic battery; and it must be understood that Mr. Mance advocates his system only as an auxiliary to other systems of field telegraphy. It would come into operation at distances when other methods are useless or tediously slow, and it compares favourably with existing systems of signalling in cheapness, range, rapidity of communication, and, last, in portability. The flashes are invisible to any one placed far to the right or left of the direct line, so that, from elevated points, far distant communications could be kept up with a fortress without the besiegers having any suspicion of the fact.

It would be superfluous to give instances, when within the last few years the use of these instruments might have brought about the most important results.

The instrument consists of a light, but firm, tripod-stand, similar to those used for prismatic compasses. On the top a plate is moved by a tangent screw which admits of quick and slow motion, and the plate carries on a pin a semicircular

* Read before the Society of Telegraph Engineers.

ring, which again carries on pivots the round mirror, the silvering of which is removed in the centre for the space of a circle about 3-16th inch diameter. To the plate is also attached a simple key, which is pressed down and springs back like an ordinary Morse key. This key is connected with the top rim of the mirror by a steel rod, which can be lengthened and shortened—as occasion may require—by turning the handle and screwing the rod through the small brass ball which secures it to the edge of the mirror.

By means of the last-named adjustment and the tangent-screw the glass can be altered, as the ever-changing position of the sun may require.

From 12 to 15 yards in front of the instrument is placed a sighting-rod. This rod is to mark a spot exactly in a line with the centre of the heliograph and the distant station. A metal stud marks the spot, and a wooden cross-piece marks where the flash rests when not directed on the opposite station.

The instrument can be set up ready for working in a few minutes. When the exact position of the distant station is not known, a flash of sunlight must be thrown in the direction of the most likely points, and this must be continued till it is answered by a flash, which indicates that a distant signalling party is on the look-out. Then, after releasing the tangent-screw, the glass must be turned to a convenient angle, and the sighting-stick must be directed in a line with the distant station by looking through the small aperture in the centre of the mirror. When this is effected, the stud must be raised or lowered till it is in the line of vision on a level with the centre of the glass and the distant flash, and the short cross-piece must be placed at right angles to the upright, about a foot below the stud. After being thus adjusted the instrument must not be moved.

The spot will be observed gradually to rise or fall, according to the direction in which the sun is apparently moving. The handle of the key, or the tangent-screw, or both, as the case may be, must be turned slightly after every two or three words, to ensure, as far as possible, that the centre of the spot shall be on the stud when the key is pressed down.

When the sun is rather low in the heavens, and behind the signaller, it becomes more difficult to direct the flash with accuracy. In consequence of the obtuseness of the angle the spot loses its circular form, and becomes rather dim when reflected on the stick. If it is required to work frequently with the sun in this position, the employment of a second glass on a light tripod stand is recommended.

But it would be useless here to enter more into the minutiæ of working the instrument: suffice it to say that, in experienced hands, twelve words and more per minute have been obtained, while others state that men—after a fortnight's practice—could attain only from four to five words per minute. As to the distance, 10 and 20 miles—and in very clear weather 40 miles—have been obtained.

A number of officers of the Indian Army have tried and reported upon the instrument, and—with the exception of one—all report most favourably of the system as an auxiliary to existing systems, and efforts are being made at the present moment to ensure their adoption for the Indian Service by the authorities.

ELECTRO-DEPOSITION OF METALS.

By J. T. SPRAGUE.

Arrangement of Objects.—This includes the consideration of several distinct conditions:—(1.) The position, horizontal or vertical. (2.) The relative proportions of objects and anode. (3.) The distances to be maintained. I propose to illustrate each of these by experiments, which the learner should study on the small scale, with a galvanometer in circuit, to show the actions set up.

Position.—Place a pair of copper strips, at least 4 inches in length, vertically in a small vessel, and pass a small current, leaving the experiment to go on quietly for a few days. It will be found that the anode is eaten away most at the top, and it will probably be cut through at the line of surface of the liquid. The cathode, on the contrary, will have a thick coating at the bottom and little at the top. There will be a thick edging of hard nodules, and the lower corners will bulge out. Probably. also, the whole surface will be marked with vertical lines, commencing in a spot, like a prolonged note of exclamation (!). Now repeat this experiment in a vessel with a porous partition having little porosity, or in two vessels connected with a syphon or a piece of cotton wick, using a nearly saturated solution of copper sulphate without acid in the anode cell. The anode will soon be covered with crystals of sulphate of copper, and the previously noted conditions will be exaggerated at the cathode. The cause of these actions is, that as the copper is dissolved at the anode a denser solution forms, which sinks and leaves acid—when present—above; or, if the solution is saturated, the newly-formed salt cannot dissolve, and crystallises where it forms. At the cathode, copper is removed from the solution, which becoming lighter, rises in a thin stream along the face, thus having less and less copper in contact with the plate.

Circulating Currents.—Now take a thin glass beaker, containing water and some powder of about equal density with water, and hold one side over a Bunsen's burner. That side will become hot, and a stream of water will flow upwards along it, flowing over the surface, descending along the cool side, and returning along the bottom. This circulating current is due to the different specific gravities of hot and cold water, and exactly resembles the conditions set up by the same cause in the depositing vessel. There we have a stream of lighter liquid running up the cathode, and of heavier solution flowing down the anode, and producing a continuation of these currents in the upper and lower strata. But the upper current is rendered acid by losing metal at the cathode, and is therefore very active where it first reaches the anode at its *upper* part: in like manner the lower stratum, having passed over the face of the anode, is highly charged with metal, and is in turn specially active where it reaches the *lower* edge of the cathode: in consequence of these two conditions an electromotive force is set up within the liquid, in a diagonal line, between these two active parts, which aids the ordinary or working current, and concentrates the action upon these parts. Most writers attribute the effect to *stratification* of the liquid, but it is the *circulating current* which does the mischief, and it is also the cause of the lines and spots: the slightest irregularity upon the surface deflects the upward flowing

current, and the obstruction constantly grows as it receives more and more of the metal brought to it by the impinging current, while the hollows are filled with weaker solution, which cannot supply so much metal.

Horizontal Arrangement.—Arrange two equal-sized plates in a deep vessel charged with a good solution, one being near the surface of the liquid, and the other near the bottom, and connect the zinc of the battery to the upper plate, making this the cathode, and allow a full current to pass for some time. If the vessel is transparent, actions similar to those just described will soon become apparent; the solution just under the upper plate will become pale in colour, the deposit forming will pass into the sandy condition, and the resistance of the liquid will increase, and eventually the plate will be found coated with bubbles of hydrogen. All these effects are due to the removal of metal from the solutions making the upper stratum the lightest, so that no mixture or circulation is produced, and from the opposite reason a dense solution—or even a deposit of crystals—forms at the lower plate. Now repeat this arrangement, but making the upper plate the anode, and observe the different result produced: the solution just below the upper plate deepens in colour, and may be seen descending through the liquid, while on the lower plate a perfectly regular uniform coat of metal, in its best condition, is steadily deposited.

It is evident, therefore, that this latter arrangement is by far the best for plates of large size, and more especially for deeply-cut medallions: it has, however, the drawback of permitting any dirt, &c., in the solution to deposit on the face of the objects, which of course interferes with regular deposit and also injures its quality: whenever such an arrangement is adopted, it is essential therefore to keep the solution very pure, by filtration, covers, &c., and it is well to use a porous division to catch any particles falling from the anode. Such a division is very readily formed of a slight wooden frame paraffined, with a cover of muslin stretched upon it, upon the surface of which a sheet of filtering- or blotting-paper can be secured: this filters the descending liquid and catches any solid particles, while its resistance is very slight.

Vertical arrangement is, however, most commonly employed, because it is most convenient: to secure a good deposit it is necessary occasionally to change the position of the objects, so as to average the irregular actions; if possible, these changes should be made without removal from the solution or break of connection, but if removal is requisite the same precautions to secure cleanliness should be observed as at the first immersion: in copper this is best effected by a momentary dip into acid at the time of replacing, and so with the suitable liquids for other metals. When striæ or nodules are seen to be forming they should, if possible, be removed by filing, burnishing, &c., before the completion of the deposit.

Proportions of Objects and Anode.—This is of consequence only so far as they may affect the conditions of working: generally it is well to have nearly the same surface area in both. The real point to be attended to is to secure, so far as possible, that all the parts of the object shall have some portion of the anode at equal distance from them, in order to maintain equality of resistance at all points, except where a less or greater thickness or rate of deposit is required.

Distance between Objects and Anode.—Use a large plate to receive a deposit, and place a very small anode close to and opposite to the middle, and pass a considerable current: it will be found that the deposit will be thick in the centre, thinning away to nothing at the edges; the thickness of deposit will, in fact, be in the opposite proportions to the distance between each point and the nearest part of the anode. Therefore the anode should be so arranged, as to form and distance, as to secure equal distances across the liquid to all parts of the object. With a regularly formed object with smooth surfaces the two may be close together, in order to diminish resistance; but irregular objects—and more especially any with portions deeply chased or undercut—require a greater distance: for suppose such a recess to be ¼ inch deep, at a distance of 1 inch this represents a quarter of the distance, and the relative deposit on the face and in the deep part would be as 5 to 4, but if the distance were 3 inches the difference would be only as 13 to 12. Such objects also require to be worked with a lower "density of current,"—that is to say, taking a longer time for a given thickness, in order to allow the liquid in the hollows to replace itself by diffusion as its metal is exhausted, a consideration of even more practical influence on the actual resistance between the several points than the mere lineal distance.

THE ROYAL INSTITUTION.

Notes of a Course of Seven Lectures on Electricity. By Professor Tyndall, LL.D., F.R.S.

February—March, 1875.

Notes of Lecture III. *February* 18, 1875.

(Continued from page 5.)

1. The next discovery throws all former ones into the shade. It was first announced in a letter addressed on the 4th of November, 1745, to Dr. Lieberkühn, of Berlin, by Kleist, an ecclesiastic of Cammin, in Pomerania. He fastened a nail in a phial into which he had poured a little mercury or spirits. On electrifying the nail he could pass from one room to another with the phial in his hand and ignite spirits of wine with it. "If," says he, "while it is electrifying I put my finger, or a piece of gold which I hold in my hand, to the nail, I receive a shock which stuns my arms and shoulders."

2. In the following year Cunæus of Leyden made substantially the same experiment. It caused great wonder and dread, which arose chiefly from the excited imagination. Musschenbroek felt the shock, and declared in a letter to a friend that he would not take a second for the crown of France. Bleeding at the nose, ardent fever, a heaviness of head which endured for days, were all ascribed to the shock. Boze wished that he might die of it, so that he might enjoy the honour of having his death chronicled in the Paris Academy of Sciences. The Leyden philosophers stated the conditions necessary to the success of the experiment, and hence the phial received the name of the Leyden phial, or Leyden jar.

3. The discovery of Kleist and Cunæus excited the most profound interest, and the subject was ex-

plored in various directions. Wilson in 1746 filled a phial partially with water, and plunged it into water, so as to bring the water surfaces within and without to the same level. On charging such a phial the strength of the shock was found greater than it had been before.

4. Two years subsequently Dr. Watson and Dr. Bevis noticed how the charge increased as the area of the non-electric in contact with the outer surface increased. They substituted shot for water inside the jar, and obtained substantially the same effect. Dr. Bevis then coated a plate of glass on both sides with silver foil, within about an inch of the edge, and obtained from it discharges as strong as those obtained from a phial containing half a pint of water. Finally Dr. Watson coated his phial inside and out with silver foil.

By these steps the Leyden jar reached the form which it possesses to-day.

5. The physiological effect of the shock was variously studied. Graham caused a number of persons to lay hold of the same metal plate, which was connected with the outer coating of the charged jar, and also to lay hold of a rod by which the jar was discharged. The shock divided itself equally among them.

6. The Abbé Nollet formed a line of one hundred and eighty guardsmen, and sent the discharge through them all. He also killed sparrows and fishes by the shock. The analogy of these effects with those produced by thunder and lightning could not escape attention, nor fail to stimulate inquiry.

7. Franklin was twice struck senseless by the shock. He afterwards sent the discharge of two large jars through six robust men; they fell to the ground and got up again without knowing what had happened; they neither heard nor felt the discharge. Priestley, who made many valuable contributions to electricity, received the charge of two jars, but did not find it painful. This experience agrees with my own. In the theatre of the Royal Institution, and in the presence of an audience, I once received the discharge of a battery of fifteen jars. Unlike Franklin's six men, I did not fall, but like them I felt nothing. I was simply extinguished for a sensible interval.

8. This may be regarded as an experimental proof that people killed by lightning suffer no pain.

9. Franklin held electricity to be a single subtle fluid; electrified bodies he thought possessed either more or less than their natural share of this fluid. Hence the terms *plus* and *minus*, *positive* and *negative*, as applied to electricity. His notion of the Leyden jar was, that whatever might be the quantity of "electric fire" thrown into the jar, an equal quantity was dislodged from the outside. The two coatings of the jar were therefore in opposite electrical conditions. These theoretic views led Franklin to the formation of his "cascade battery."

10. Franklin sought to determine the *seat* of the charge in the Leyden jar. He charged a bottle containing water: dipping a finger into the water and touching the outside coating he received the shock. He was thus led to inquire, Is the electricity in the water? He poured the water into a second bottle and found that it carried no electricity along with it.

11. "He then judged that the electric fire must either have been lost in the decanting, or must remain in the bottle; and the latter he found to be true, for filling the charged bottle with fresh water he found the shock, and was satisfied that the power of giving it resided in the glass itself."* An account of Franklin's discoveries was given by himself in a series of letters addressed to Peter Collinson, Esq., F.R.S., from 1747 to 1754.

12. By rendering the coatings of the Leyden jar movable the jar may be charged, the interior coating removed, placed on the ground, and proved unelectric. The jar may then be removed from the outer coating and the latter proved unelectric. Restoring the jar and coatings, on connecting the two latter, the discharge passes in a brilliant spark.

13. As experimental knowledge increased thought became more definite and exact as regards the relation of these electrical effects to thunder and lightning. The Abbé Nollet thus quaintly expresses himself: "If anyone should take upon him to prove, from a well-connected comparison of phenomena, that thunder is, in the hands of nature, what electricity is in ours, and that the wonders which we now exhibit at our pleasure are little imitations of those great effects which frighten us, I avow that this idea, if it was well supported, would give me a great deal of pleasure." He then points out the analogies between both, and continues thus: "All those points of analogy, which I have been some time meditating, begin to make me believe that one might, by taking electricity as the model, form to one's self in relation to thunder and lightning, more perfect and more probable ideas than what have been offered hitherto."†

14. These views were prevalent at this time, and out of them grew the experimental proof by Franklin of the substantial identity of the lightning flash and the electric spark.

15. But before entering further on the facts of electricity, it will be well to seek some theoretic guidance. The insufficiency of the facts of observation to appease the desires of the mind has been already mentioned. In the midst of facts we long for principles to connect them, and to present them in their proper relations.

16. Accordingly, side by side with the phenomena hitherto illustrated there ran a vein of speculation, more or less vague, as to the nature of electricity itself. In thus speculating we quit the field of observation, and draw upon the constructive imagination, which, guided by existing knowledge, forms the physical principle, and commits it to the process of experimental deduction to test its sufficiency and truth.

17. Thus, in relation to electricity, Boyle had his unctuous effluvia, Newton his ether, Du Fay his vitreous and resinous electricity, Nollet his affluences for repulsion, and his effluences for attraction, Franklin his single electric fluid, and, finally, Symmer his theory of two electric fluids.

18. The simplicity of Franklin's theory of a single electric fluid is only apparent. It involves consequences of a very doubtful kind. In accounting by it for the mutual repulsion of negatively electrified bodies, we are driven to the assumption that ordinary matter is self-repulsive.

19. The theory of two fluids is by far the most convenient. Still, though it is a principle of ex-

* Priestley's "History of Electricity," 3rd edition, p. 149.
† Priestley's "History of Electricity," pp. 151—52.

treme simplicity, and of great power in uniting electrical phenomena, it is to be regarded rather as an image of the mind than as a physical reality.

20. According to this theory, electrical phenomena arise from the action of two fluids, each self-repulsive, but both mutually attractive. Every body in its natural condition possesses both fluids in equal quantities. As long as the fluids are mixed together they neutralise each other; the body in which they are thus mixed being in its natural or unelectric condition.

21. By friction, and various other means, the two fluids are torn asunder; the one clinging by preference to the rubber, the other to the body rubbed.

22. As a matter of fact the rubber and the body rubbed are always oppositely electrified.

23. When smooth glass is rubbed with silk the glass is electrified positively and the silk negatively. When sealing-wax is rubbed with flannel the wax is electrified negatively and the flannel positively.

24. These terms are adopted purely for the sake of convenience. There is no reason in nature why the resinous electricity should not be called positive, and the vitreous electricity negative. Once agreed, however, to apply the terms as fixed in (23) we must adhere to this agreement throughout.

25. When electricity is communicated to a conductor it distributes itself over the surface; but the mode of its distribution depends upon the form of the conductor.

26. On an insulated sphere it distributes itself equally all over the surface. Riess expresses this by saying that the electric *density* is the same at all points of an electrified spherical conductor.

27. But this is only true of a sphere. If the conductor be elongated, the electricity is densest at the ends. If it be a cone, different electric densities are observed at the apex and base of the cone, and on the conical surface. Were the cone *perfectly* sharp—if the apex ended in a mathematical point, the theoretic density would be infinite. No electricity whatever could exist on such a pointed body; it would be instantly diffused through the air.

28. The more perfect the point of an electrified body, the greater will be the electric density, and the greater the tendency to diffusion. By determining the electric density Riess finds the thorn of the euphorbia sharper than an English sewing-needle, which, however, excels in sharpness the thorns of the gooseberry, the cactus, and the rose.

29. It is the intense electrification of the air at a point and its consequent repulsion that produces the electric wind. It is the escape of the electricity from a point which renders the charging of a conductor on which a needle, or other pointed body, is placed, difficult: it is the copious outflow of electricity which renders it possible by means of a point to convey electricity to bodies at a distance.

30. We have now to apply the theory of electric fluids to the important subject of electric *induction*.

31. It was noticed by early observers that *contact* was not necessary to electrical excitement. Stephen Gray, for example, by bringing his excited glass tube near one end of a conductor, attracted light bodies at the other end. Canton, in 1753, suspended pith-balls by thread, and holding an excited glass tube, at a considerable distance, caused them to diverge. On removing the tube the balls fell together, no permanent charge being imparted to them. Such phenomena were further developed by Wilcke and Æpinus; while Coulomb's measurements and Poisson's calculations extended and defined our knowledge of the subject.

32. These and all similar results are embraced by the law, that when an electrified body is brought near an unelectrified one, the neutral fluid of the latter is decomposed; one of its constituents being attracted, the other repelled. When the electrified body is withdrawn, the separated electricities flow again together and render the body unelectric.

33. This decomposition of the neutral fluid by the mere presence of an electrified body is called *induction*. It is also called electrification by *influence*.

34. If, while it is under the influence of the electrified body, the influenced body be touched, the free electricity (which is always of the same kind as that of the influencing body) passes away, the opposite electricity being held captive.

35. On removing the electrified body the captive electricity is set free, the conductor being charged with electricity opposite in kind to that of the body which electrified it.

36. Numberless other experiments are suggested and explained by the principle of induction. It explains why neutral bodies are attracted by electrified bodies. In reality the bodies attracted are *not* neutral: they are electrified by influence; and it is in virtue of their being thus electrified that they are attracted.

37. It explains the "discharge" of an electrified conductor by a point. For the induced electricity becomes so dense upon the point that it streams out against the inducing body and rapidly neutralises it.

38. It explains the fact that when a point upon an insulated conductor is turned towards an electrified body, the conductor charges itself with the same electricity; and that when the point is turned away from the electrified body the conductor charges itself with the opposite electricity. In the first case the unlike electricity is *drawn* away by attraction; in the second case the like electricity is *driven* away by repulsion.

39. It explains the first approach and subsequent retreat of the gold leaf noticed by Du Fay. For the edges and corners of the leaf, acting like points, discharge the opposite electricity against the influencing body. The leaf being thus rapidly charged with electricity of the same kind as that of the influencing body, repulsion is the consequence.

40. There is also a discharge of the electricity similar to that of the influencing body from the more distant portions of the leaf, to which that electricity is repelled. Both discharges are accompanied by an electric wind. It is possible to give the gold leaf a shape which shall enable it to float securely in the air by the reaction of the two winds issuing from its opposite ends.

41. Well-pointed lightning conductors when acted on by a thunder cloud behave in the same way. The opposite electricity streams out from them against the cloud.

42. Franklin saw this with great clearness, and illustrated it with great ingenuity. The under side of a thunder cloud when viewed horizontally, he

observed to be ragged, composed of fragments one below the other, and sometimes reaching near the earth. These he regarded as so many stepping-stones which assist in conducting the stroke of the cloud. To represent these by experiment he took two or three locks of fine loose cotton, tied them in a row, and hung them from his prime conductor. When this was excited the locks stretched downwards towards the earth; but by presenting a sharp point erect under the lowest bunch of cotton, it shrunk upwards to that above it, nor did the shrinking cease till all the locks had retreated to the prime conductor itself. "May not," says Franklin, "the small electrified clouds, whose equilibrium with the earth is so soon restored by the point, rise up to the main body, and by that means occasion so large a vacancy, that the grand cloud cannot strike in that place?"

Experiments in Lecture III.

(1.) Early forms of Leyden jar illustrated. A small phial, two-thirds filled with water, with a cork in the neck, and a nail long enough to reach the water through the cork; a similar phial two-thirds filled with shot. Clasping either phial with one hand, and charging it, a smart shock is experienced when the nail is touched with the other hand. In this and other experiments a rubbed glass tube suffices to charge the jar, though this is more rapidly done by the electrical machine.

(2.) Water in wide glass vessel; a second glass vessel immersed in the first, and filled to the same height with water. Outer water connected by a wire with the earth; inner water connected by a wire with the electric machine; one or two turns furnish a sufficient charge. Removing inner wire and dipping one finger into the outside, and the other into the inside water, a smart shock is experienced. Placing in the inner water a metal stem and knob, and charging strongly, a brilliant spark passes on connecting the earth-wire with the knob.

(3.) Glass jar coated (not too high) with tin-foil; filled to the same height with water, placed on india rubber cloth, and charged by connecting outside coating with the earth, and the water (by means of a cemented stem and knob) with an electric machine. Bright spark on discharging. Recharge. Taking hold of jar with india-rubber, pour water into second similar jar; no sensible charge imparted. Pour fresh water into first jar; retention of charge shown by brilliant spark. Edge of jar out of which water is poured to be surrounded by a band of bibulous paper to catch final drop.

Note:—"Carriers" formed of pieces of copper-paper with shell-lac, or ebonite handles, are very useful.

(4.) Jar with movable coatings charged. Touch knob with carrier—it attracts lath balanced on egg. Remove inner coating and place it on table; the small amount of electricity which it carried away is thus discharged, and the knob now shows no power of attraction. Remove glass vessel; the outer coating is also found neutral. Restore glass and inner coating; lath immediately attracted by carrier which has touched restored knob. Discharge jar: a brilliant spark.

(5.) Glass plate 9 inches square; tin-foil on both sides 6 inches square. Connect one side with earth and the other with machine. Charge and discharge: a brilliant spark.

(6.) Ordinary Leyden jar; charged and discharged.

(7.) An elongated metal conductor, or one formed by coating wooden roller with tin-foil, is supported on warm glasses or by a glass pillar: small weight suspended by silk ribbon placed on one end: excited glass tube placed over the other end. Weight now removed is charged with electricity and attracts lath. This is the experiment of Æpinus.

(8.) Sphere of wood coated with tin-foil: placed on warm tumbler: excited glass tube brought near: touch distant part of sphere with carrier: it attracts lath. Touch surface adjacent to excited tube, it also attracts lath. The first charge repels excited glass needle, and is therefore positive: the second repels excited gutta-percha, and is therefore negative. One of these charges, moreover, neutralises the other in the gold-leaf electroscope.

(9.) While the glass tube is near the sphere, touch the latter anywhere with the finger, then touch distant part of sphere with carrier: no action. Now remove glass tube and touch again with carrier: strong action. The electricity liberated by the removal of the tube proves to be negative.

(10.) Two insulated spheres are caused to touch; excited glass rod is held near one of them and they are then separated. The one is now charged with positive, the other with negative, electricity.

(11.) I stand on an insulating stool: present the right hand to the balanced lath, and stretch out the left arm. An assistant brings excited glass tube over that arm, lath immediately follows hand.

(12.) I touch the lath and all "virtue" disappears (the lath is not insulated). After this, as long as the excited tube is held over the arm there is no attraction: on its removal attractive power is restored. Here the first attraction was by positive electricity driven to the hand, and the second by negative electricity, liberated by the removal of the glass rod. The one repels rubbed glass, the other repels rubbed gutta-percha; and on charging the electroscope with both they neutralise each other.

(13.) I stand on insulating stool, and place the right hand on electroscope: no action. I stretch forth the left arm and permit an assistant alternately to bring near, and to withdraw, an excited glass tube. The gold leaves open and collapse in similar alternation. At every approach positive electricity is driven over the gold leaves; at every withdrawal the equilibrium is restored.

(14.) In all cases the rubber, whether it be of silk or of flannel, attracts balanced lath. The silk rubber repels rubbed gutta-percha, and is therefore negative; the flannel rubber repels rubbed glass, and is therefore positive. Laying silk rubber on electroscope, leaves diverge. Laying flannel rubber on silk one, leaves close again; the one rubber neutralises the other, and each of them in relation to the body it has rubbed is oppositely electrified.

(To be continued).

THE BOAT RACE.

Rowed for the first time in 1829, over the course at Henley-on-Thames, the Oxford and Cambridge Universities Boat Race has increased steadily in public favour until it has become as genuine an institution as the Derby, or the Cup day at Ascot. Not for some years, however, did it take its

place as an annual fixture; for we find that between 1829 and 1836 there was no race, and that down to the year 1856 the event was several times intermitted. From 1836 until 1842 the race was rowed from Westminster to Putney; between 1842 and 1845 there was no race, and in the latter year the course was changed to that now rowed over—viz., from Putney to Mortlake. Once or twice, down to the year 1863, the course was reversed, and the boats steered down the river from Mortlake to Putney; but from 1864 onwards the course has been that which has become familiar to the whole of London—we had almost said to the whole country. In all, the race has been rowed 32 times during the 45 years it has been in existence; and Oxford has been successful 17 times against 15 victories scored for the sister University. Latterly, the victories have gone in cycles, Oxford having won during the nine successive years between 1861 and 1869 inclusive; and Cambridge having scored five victories in succession down to last year. Whether the result of this year's race, which took place last Saturday week, is an indication that the tide has turned once more in favour of the Isis, as against the Cam, time alone will reveal. But time can scarcely alter, otherwise than to intensify the interest which is manifested year after year in the great aquatic event of the time—the "blue riband" of the Thames. When the race was rowed over the picturesque course at Henley 45 years ago, the distance was only 2¼ miles; yet the time occupied was 14¼ minutes, and over this short distance Oxford is recorded as having been victorious by "many lengths." The course from Putney to Mortlake is slightly over 4 miles, and it is interesting to note how the speed of the rowing has increased with the lapse of years since the race was first inaugurated. During the past five years, the *average* duration of the race has been 21 min. 44 sec. But in 1873, when sliding seats were used for the first time, the time occupied in covering the 4 miles was only 19 min. 35 sec., or about 5 minutes longer than was occupied at Henley in covering little more than half the distance. The course between Putney and Mortlake may be almost described as classic ground. Its landmarks are as well-known as those of the most frequented thoroughfares in London; and the mere mention of the "Soap Works," "Biffen's," the "Oil Mills," "Chiswick Eyot," "Corney Reach," "Barnes Bridge," or the "Ship," is enough to conjure up all the scenes of the exciting contest, and to suggest minute calculations as to the number of lengths ahead.

But besides being a great gala, the boat race is an event in our telegraphic annals not to be altogether despised. Not that it dates back a very long way in this respect; for although the wires are now carried to the water's edge at Henley on the occasion of the annual regatta at that picturesque little town, it is to be feared that no such "facilities" existed in connection with the first University Boat Race held there 45 years ago. Indeed, the telegraph had hardly been thought of at that time; and it was almost 10 years later that Cooke and Wheatstone took out their first patent for our dear old friend, the "Double Needle." It is doubtful whether, prior to the transfer of the telegraphs to the Post Office, any special efforts were put forth to stimulate telegraphy in connection with the event. But it is quite certain that immediately after the transfer, the opportunity was seized upon to bring grist to the mill of the ever-going-round postal system. In 1871, a temporary office was opened on the Boat Race day, under the stand adjoining the "Ship" at Mortlake; but the result appears to have been only indifferent, as no record was kept of it. In 1872, the matter was taken in hand by the Special Arrangements Branch of the Telegraph Department; and the completion in that year of the Travelling Telegraph Office enabled a fair trial to be made at Mortlake. As many as 357 messages, of the value of £19, resulted from the operations there and at Putney; and it became clear that a business was to be done with improved arrangements and increased wire accommodation. In 1873, the smaller telegraph-carriage was stationed at Putney, adjoining the "Star and Garter," so that temporary offices were established at the start as well as at the finish of the race; and what with this, and the increase of facilities at Hammersmith, Barnes, and other intermediate points, the number of messages suddenly rose to 698. In 1874, the arrangements were of a somewhat similar character, but no very marked increase of business resulted in that year, the number of messages being only 723. Last Saturday week, however, a very decided improvement was effected in the telegraphic arrangements. Carriages were stationed at Putney, Hammersmith Bridge, and Mortlake, each having direct and independent communication with the central station, and monopolising amongst them no fewer than five wires—viz., two at Mortlake, two at Hammersmith, and one at Putney. The start was exhibited at Hammersmith and Mortlake, and the finish at Hammersmith and Putney, within 10 secs. after each event; and the result of the race must have been known at Putney at least a quarter of an hour before it could possibly have been known under previous arrangements. The natural result of this enterprise on the part of the Post Office was to largely increase the amount of telegraph business transacted as compared with that of former years. Upwards of 1000 messages, and more than three columns of news for the press, were transmitted in connection with the event, and by far the largest proportion of this work was disposed of in the temporary offices stationed along the river side. At Hammersmith, the experiment of opening a temporary office adjoining the Bridge House was so successful, that 120 messages were handed in within a few minutes after the result of the race was known: while, at Mortlake, no fewer than 310 messages were disposed of within about two hours after the race was over. At the Post Offices at Putney, Hammersmith, and Barnes, a considerable increase of telegraphing was experienced in connection with the event of the day, and altogether 1040 messages resulted from the operations which we have thus minutely described. It would be a mistake to suppose that the interest in the Boat Race is purely local, or even British, for we understand that no fewer than 20 telegrams were forwarded to the Continent and elsewhere abroad in connection with the event.

A curious development of telegraphic business relating to the Boat Race is to be found in the operations of press correspondents conducted by means of the wires. One would imagine that the

proximity to London of the scene of action would render newspaper telegraphing altogether unnecessary; but this is not so. For days prior to the race, the evening papers have regularly appeared with the heading, "Latest from Putney;" and on the morning of the eventful day, every movement of the crews, down to the very second at which the start is effected, and the fact of which boat catches the water first, is religiously wired at frequent intervals to Fleet Street and the Strand. The result, of course, is telegraphed everywhere—even to distant Bombay and more distant Melbourne—and the rapidity with which this was effected last Saturday week may be imagined from the fact that the *Standard* newspaper was on sale in Fleet Street within one minute after the race was finished at Mortlake. One enterprising news agency has made all sorts of efforts to keep its subscribers advised of the progress of the race from point to point, even to the paying out of a wire from the stern of one of the accompanying steamers, and the laying of a cable beforehand along the bed of the river. But under the improved arrangements made by the Post Office this year, nothing of the kind was attempted, and before another year it is hoped that still further improvements will be carried out.

Notes.

Electric Science occupies a place of no mean importance in the new Opera House in Paris. A special room is set apart as a battery room, in which 360 Bunsen's cells, arranged in sets of 60 on rough plate-glass tables, are manipulated to pass a current in any part of the stage so as to direct the electric light upon any point of the scenery. The sunlight and startling effects produced by French scenists are really beautiful. The rainbow in Mosé is wonderful.

The Tale of a Rat in our last number recalls a somewhat different tale of a mouse, which happened on the sea-wall near Dawlish, where the wires (gutta-percha) are carried in grooved boarding. Periodical contacts of short duration were observed, which were totally independent of any change in the weather. They were found to be due to the effect of the calls of nature of a mouse, who had made her nest, reared her progeny among the wires, and partially devoured their insulating protection.

Our contemporary, *Nature*, has commenced a series of articles on "The Progress of the Telegraph," from which our readers will be surprised to learn that "up to 1844 electrical knowledge was more or less confined to the lecture table; *crude* experiments upon frictional electricity, and the elements of magnetic and voltaic phenomena, constituted the portfolio of knowledge as accepted by the public," and that little or no progress was made until "In 1848 Holmes gave to telegraphy the practical result of his researches as regards the rapid transmission of signals over extended circuits!" The name of Sir William Cooke—the father of the English telegraph system—is scarcely mentioned! and inductive capacity and absorption are said to be the same thing!!

Proceedings of Societies.

SOCIETY OF TELEGRAPH ENGINEERS.

The Annual General Meeting was held on the 9th December, 1874. Mr. Latimer Clark, Vice-President, in the chair. The annual report was read, and the ballot for President and Council took place, with the result of which our readers are well acquainted. Later in the evening, Lieut. Jekyll, R.N., read an interesting paper on the "*Telegraph in the Ashantee War*," describing many interesting details as to the difficulties of constructing a line of telegraph through a country so heavily covered with wood and undergrowth. The difficulty was enhanced by the unhealthy nature of the climate, which also increased that of signalling. Bamboos were used as poles, with insulators fastened into the top. The telegraph answered perfectly for all the various requirements of the war.

In the discussion which followed, the question again turned on the relative merits of "sound" versus "record" for instruments for military purposes; it was noticed on this occasion that gentlemen who were formerly in favour of a record were now most decidedly in favour of sound.

The value of the telegraph in connection with warfare was still further exemplified by the military speakers, and cordial recognition was made of the assistance rendered by the Postal Telegraph Department in supplying stores with remarkable celerity.

At this meeting 50 candidates were elected, thus bringing up the total number of all classes of members to 645.

The Ordinary Meeting was held on the 13th January, 1875. Mr. Latimer Clark, President, in the chair.

The President delivered his inaugural address, which has appeared *in extenso* in these columns.

The Ordinary General Meeting was held on the 27th January, Professor Foster, F.R.S., in the chair.

A paper was read by Mr. C. Becker on "*The Heliographs of Mr. Henry Mance.*" (See p. 73.)

Subsequently a paper was read from Mr. Graves, of Valentia, "*On Vibrations due to Earth Plates.*"

Mr. Graves called attention to the great difficulties experienced in the early working of the Atlantic Cable by vibration of the spot of light of the mirror instrument, which ultimately were found due to the polarisation of the earth-plates. The various earths had been arranged in the most systematical order, with the object of serving the several cables without undue interference; but after repeated experiments, the earths were found to produce these vibrations, whatever combination was used; finally they were not got rid of until earth was actually made with the outside sheathing of the cable. As the earth-plates were separated from the office at great distances, the question became of some interest, and it was at length necessary to make earth for every cable on to its exterior sheathing. It, therefore, became necessary in providing for every new cable to provide also a companion earth wire from the office to the cable hut. Mr. Graves attributes the result to the partial insulation of the telegraph station and its locality from

he main land due to its peculiar geological formation.

In the discussion which followed, the effects stated by Mr. Graves were explained by Mr. Preece as due to the simple effect of polarisation of the various earth-plates, causing slight opposing currents to be constantly passing, and thus accounting for the slight but constant movements of the spot of light.

At the usual ballot, 23 candidates were admitted into the Society.

Notices of Books.

Exposé des Applications de l'Electricité. Par le Comte TH. DU MONCEL, Officier de la Légion d'Honneur et de l'Ordre de St. Wladimir de Russie; Ingénieur-Electricien de l'Administration des Lignes Télégraphiques Françaises. 3e Edition Entièrement Refondue. Paris. 1872.

THIS famous work of the Count du Moncel's is too little known amongst the majority of English physicists. It is more than its title indicates. For it contains an excellent outline of the theoretical part of dynamic electricity as well as the fullest and minutest details of the practical applications of this invaluable form of energy. With that indefatigable industry which is characteristic of the author, Count du Moncel has gathered into these volumes the majority of the innumerable modifications and improvements in electrical instruments that have been made in late years.

The surprising amount of fertility of invention that exists in various parts of the world is shown nowhere more strikingly than in the perpetually-recurring crop of new electrical devices, good, bad, and indifferent. Count du Moncel's experience has enabled him to select the most valuable of these inventions, and in many cases he gives the results of his own careful experiments made for the special purpose of testing their utility. French discoveries and improvements in electrical instruments naturally have the preponderance in these volumes, but ample justice is done to English science, nor have the chief additions made by other nations been neglected. The issue of a third edition has enabled M. Moncel to add to the value of his work by increasing the size and scope of the undertaking, so that he now gives us a complete theoretical as well as practical view of the science of electricity.

The first volume, of about 500 pages of small type, is devoted to what the author terms the "technology" of electricity. That is to say, all the technical knowledge that is necessary for the application of electric currents. Hence, in this volume, we have a capital *exposé* of Ohm's law and the practical deductions therefrom, a detailed examination of the various batteries—and their name is legion,—including a description of secondary batteries and earth batteries; then comes an excellent account of the British system of electrical units; and, finally, the practical methods adopted in electrical measurements, with the theory of each method very clearly stated. The second volume discusses the laws of electro-magnetism, and the best conditions for the construction of electro-magnets; then follows a description of the various electro-magnetic contrivances, and of the construction of induction apparatus; then a full account of the electrical apparatus employed in experimental inquiries; and the volume concludes with an explanation of the different systems employed in telegraphy. The third and fourth volumes, which are to follow, we have not yet received. The exhaustive manner in which the subject is handled in the first two volumes leads us to look forward with interest to the remaining parts of this invaluable work. Unquestionably, Count du Moncel has given to practical electricians one of the most important and useful works ever published on their special subject. The value of such a work as this to inventors as well as to students cannot be over-estimated, when one considers the loss of time and capital that yearly takes place from the re-discovery of instruments, or modifications of apparatus, against which loss such a *resumé* as this will most effectually guard.

We will now give our readers a few extracts of interest translated from the two volumes before us. Here is a method for amalgamating zincs that will everywhere be found useful, and which is new to us:—

"Several methods have been proposed for amalgamating zincs; but the simplest and quickest is that of M. Berjot (a chemist at Caen), which consists in immersing the zinc in a liquid composed of nitrate of mercury and hydrochloric acid. A few moments is sufficient for the complete amalgamation of the zinc, however soiled its surface may be. With a litre of this liquid, which costs less than two shillings, 150 zincs can be amalgamated. The liquid should be prepared in this manner:—Dissolve in warm water 200 grms. of mercury in 1000 grms. of aqua regia (nitric acid 1 part, hydrochloric acid 3 parts). When the mercury is dissolved, add 1000 grms. of hydrochloric acid."

In connection with this subject, the following preparation for amalgamating iron is very simple, although we cannot answer for its efficacy:—

"On carefully-cleaned iron, pour a solution of chloride of copper in hydrochloric acid; a thin coating of copper will be deposited. A solution of bichloride of mercury in hydrochloric acid is applied to this, and the surface is now thoroughly amalgamated."

In regard to the economical application of electricity, no subject is so important as the relative merits of different forms of batteries. For illuminating purposes and lecture demonstration we have hitherto had to rely upon the Bunsen or Grove battery. But, during the siege of Paris, a form of bichromate of potash battery, known as the "Chutaux" battery, was frequently employed to yield the electric light used on the ramparts. The author gives a full account of different forms of the Chutaux battery, and furnishes some interesting data for the comparison of the Chutaux and Bunsen battery when giving the electric light. The following results were obtained from the two batteries, each being composed of 48 cells, and each working for two hours:—

BUNSEN'S BATTERY.

Light equal to At beginning.	End.	Mean.	Surface of Zinc employed.
109	66	87·5	49,428 c.c.

Carcel lamps.

CHUTAUX BATTERY.

Light equal to At beginning.	End.	Mean.	Surface of Zinc employed.
132	63	97·5	14,400 c.c.

Carcel lamps.

In working each of these batteries, for half-an-hour successively, the following results were found:—

		Bunsen. Light Equal to	Chutaux. Light Equal to
1st period of half-an hour		109 Carcel lamps.	132 lamps.
2nd ditto	Beginning	134 lamps.	128 ,,
	End ..	37 ,,	100 ,,
3rd ditto	Beginning	106 ,,	80 ,,
	End ..	97 ,,	51 ,,
4th ditto	End ..	66 ,,	63 ,,

According to these figures, the bichromate of potash battery flags much quicker than the nitric acid battery, a fact which evidently depends on the polarisation of its plates, to which it is always liable. It is, however, more economical.

One rather important advantage of these batteries is that they can be kept in a closed place without giving out any odour or unhealthy emanation; besides this, the liquid evaporates slowly. The author had also been able to verify the statement that, after a battery had been charged for more than a year, and then left alone, it had lost hardly anything of its power. We regret that the relative consumption of zinc and acid, and the comparative cost of working of the whole battery are not given; but so far as the foregoing data are concerned, the Chutaux evidently promises extremely well. For lecture purposes an electric light is rarely wanted for more than half-an-hour, the great desideratum being a rapid means of charging and discharging the battery. In this respect nothing could be better than the Chutaux; being a single fluid battery, the plates can be raised and lowered easily and rapidly. One of the characteristics of this bichromate battery is the constant percolation of fresh solution through the battery; by this means a good deal of the bad effect of polarisation is got rid of. Here is the composition of the solution for his batteries recommended by M. Chutaux:—

Water	1500 grms.	
Bichromate of potash ..	100	,,
Bisulphate of mercury ..	50	,,
Sulphuric acid	200	,,

The electromotive force of such a cell is at first more than twice that of a Daniell cell, but in duration it cannot, of course, be favourably compared.

The cost of working the Chutaux Count du Moncel finds to be about 1·75 francs per cell, which he states is less than that of a Daniell cell, the advantage being that in the Chutaux an electromotive force of nearly double is obtained, and an internal resistance less than half that of the Daniell, besides other obvious advantages noticeable in the working of the two forms. A battery of 24 Chutaux cells, according to our author, can furnish a fairly brilliant electric light at a cost of about 7½d. per hour. If this be the case, the Chutaux battery will rapidly come into use for the purposes of lecture demonstration.

To obtain a transitory current of high potential, nothing seems better adapted than a secondary battery of M. Planté's form. Count du Moncel has fully described these batteries. They consist, as our readers probably know, of either a sheet of lead rolled into a spiral, or successive strips of lead, immersed in dilute sulphuric acid. When the poles of a secondary battery are joined up with two or three Grove cells for a few minutes, finely-divided lead is precipitated on one electrode, and a film of peroxide of lead on the other. Disconnecting the Grove cells, the Planté battery now gives an intense current of its own, which lasts a short time. Here are some effects of the secondary battery. A Planté battery of forty couples joined up with three Bunsen cells for twenty minutes then yielded a current which raised a platinum wire 2 metres long and ½ m.m. diam. to incandescence for forty-five seconds, or gave a good electric light for half a minute. Like the residual discharges from a Leyden jar, these batteries can yield successive discharges after a period of rest.

Terrestrial batteries furnish a constant and inexpensive source of electricity. The author describes many forms of earth batteries, which usually depend upon the oxidation of zinc by the humidity of the soil, or the action of the sea water on which they may be floated. A system proposed by M. Lenoir has, however, advantages over the ordinary form. The plates of zinc and coke are placed, each separately, in a large porous vessel filled with moist earth. To one of these vessels is added water containing only a few drops of nitric acid, and to the other (containing the zinc) is added some salt water. M. du Moncel remarks—"In this manner a kind of Bunsen element is obtained, which has considerable power relatively, and far greater constancy, than ordinary terrestrial batteries. This constancy is mainly due, according to M. Lenoir, to the presence of the nitric acid, which weakens the effects of polarisation; M. Lenoir has indeed observed that, without nitric acid, the current produced by this battery soon loses its intensity, but five or six drops of this acid are quite sufficient to give a very marked constancy to the electric current. One very important consequence of employing these currents is that, if used for telegraphic purposes, the insulation of the line wires no longer needs to be so complete as with the ordinary batteries; even when a leakage to earth has been purposely made,—offering but little resistance,—the working of the line has been still quite easy to carry on."

Thermo-electric batteries have as yet been unable to compete with chemical action batteries, but there can be no doubt they will come into extensive use when a pair of metals can be found giving a higher potential and capable of enduring a higher temperature than those hitherto employed. In the work before us, there is a complete *resumé* of the various thermo-batteries. Mure and Clamond's battery seems, so far, the best form. The metals are bars of galena and strips of iron heated by gas or coke, and improved forms of this battery have lately been fully described in this journal. The largest thermo-battery made by Mure and Clamond is one of 150 large couples, equal to about 5 Bunsen cells, and one of 560 small couples, equal to about 60 Daniell cells; each consumed some 800 litres of gas per hour in heating the plates. MM. Mure and Clamond even assert they can construct these batteries equal to 50 Bunsen cells. It would be an invaluable invention if they could be made thoroughly reliable; our kitchen fires, or the backs of parlour grates, might then furnish us with light in our rooms, and the rays of the summer sun might then be transmuted into telegraphic messages. Unfortunately, our experience of these thermo-electric batteries has not been favourable to them, but we live in the age of discovery, and so hope for the revelations of to-morrow.*

Our space forbids us to enter as fully as we could wish into the details of the second volume. Here, as already remarked, is given the amplest information concerning electro-magnetic, magneto-electric, and induction apparatus. Gramme's machine is fully described, and in the appendix its subsequent improvements are added; also the most recent modifications of the various allied machines. In the second chapter, devoted to induction by frictional electric machines, there is the fullest description with which we are acquainted of the numerous species of continuous electrophori, of which the Bertsch, Carré, and Holtz type are best known. We quite agree with the author as to the superiority of the Carré machine. Those who need a thoroughly reliable and powerful electric machine will find in the vulcanite Carré an instrument always ready for use, and not liable to get out of order.

In the fourth section we come to the instruments for, and the methods of, measuring currents. Here we have a perfect galaxy of galvanometers. Galvanometers to suit any current, any object, and any taste. There are few text-books where Weber's instruments are described; here they may be found in full. We

* Since writing the above we have seen a Noé's thermo-battery of 96 elements in action at Mr. Gore's laboratory at Birmingham. This battery is far superior to any that we have tried before; roughly judged, it is equal to about 4 Grove cells, but its elegant arrangements and reliability at any moment make it a most valuable adjunct to a laboratory.

notice a misprint here,—'shunt' is spelt 'schunt.' The word agomètre is new to us; it stands for rheocord, or the double wire arrangement used as as a simple form of rheostat: but the sliding mercury connections are not good,—a metallic clip is better. Coming to electrometers, we find an extremely full and trustworthy account of Sir W. Thomson's quadrant electrometer and replenisher.

The latter portion of this volume is replete with technical information more fitted for the telegraph engineer than the student of science. Here we have the construction and derangements of aërial, subterranean, and submarine lines; the nature of the various faults, and their detection; the disturbances to which telegraph lines are subject; and other practical matters, in which we meet with much that is new and interesting.

In conclusion, we can only repeat in a few words what is evident throughout our notice of this standard work—that it is unquestionably the best treatise we know on the applications of electricity, in the widest signification of the term. It is a work that should be in the cabinet of every physicist, and in the hands of every telegraphic engineer.

Electricity: its Theory, Sources, and Applications. By JOHN T. SPRAGUE, Memb. Soc. Tel. Eng. London: E. and F. N. Spon.

IT is quite refreshing to read a really new book on electricity. Here we have a work which discards the old text-books, bundles over-board the old theories, sets asides old terms, renounces old units and in place thereof introduces new units, re-defines such ancient terms as cannot be sent to the right-about, boldly advances new doctrines, and offers to the reader what with many defects is really a useful and valuable book. The author is evidently a self-worker and a self-thinker, and, like all such "self-help" men, is very dogmatic. "I am Sir Oracle, and when I ope my lips, let no dog bark." Thus "it is stated as a fundamental law that bodies similarly electrified repel each other, *which is not true*, so stated." The italics are the author's, not ours. He has introduced the conceptions of atoms and molecules into matter, and of energy and motion into force, and has shown how electricity is essentially a form of energy and a property of the molecules. He has boldly accepted the doctrine germinated by Faraday and slowly creeping into scientific belief that electricity and magnetism are due to the polarity of molecules, and that we are to search for it not so much in the conductors that bring it within the cognizance of our senses as in the insulating media that are inseparable from its manifestations. It must be confessed, however, that in his explanations of molecular effects he is occasionally hazy; but this is due more to the fogginess of the subject itself than to the style of the author who, when he deals with subjects with which he is practically acquainted, as in electrolysis and electro-metallurgy, is remarkably clear and explicit.

He explains the principles and general phenomena of static or frictional electricity on these views, and gives sound, clear, and very practical directions for the manipulation of instruments designed for the production and manifestation of this branch of the subject. A chapter is devoted to those magnetic phenomena which bear intimately on electricity, and galvanic batteries receive very ample treatment; but he is unjust to M. Leclanché, who has done more real good work towards improving practical working batteries than any one excepting Mr. Fuller (who is not mentioned by Mr. Sprague) since Daniell. Lightning and lightning conductors, electro-magnetism, electric measurements of all kinds, complete a decided addition to our electrical literature.

We, however, come across some very strange paragraphs in a book "written chiefly for that large and increasing class of thinking people who find pleasure in the study of science, and seek to obtain a full and accurate scientific knowledge for its own sake, or as part of the necessary mental preparation for many of the departments of modern life." Speaking of a graduation of a tangent galvanometer,—

"But while I explain this process for the benefit of readers, it is necessary to remark that no one is at liberty to make for sale galvanometers whose dials are thus graduated to indicate the values of the current and resistances in definite units in place of mere degrees of arc, *as this construction is patented.*"

Again:—"I saw also that the plan I had long used personally of measuring currents direct, as described (*but which no one else appears ever to have thought of as applicable to galvanometers*), might be extended so as to make them read off resistances in ohms without the use of the expensive resistance coils. From these ideas has been developed an instrument *which will soon be accessible to the public*, and will, by simplifying the processes of measurement, and placing them fairly in view, tend to spread generally those definite ideas of the measurement of electricity which make it a science instead of a mere hotch-potch of isolated facts, but which are at present confined almost entirely to professional electricians. . . . It shows the current in vebers and in chemics as well as in degrees. It can be made to show any special work, such as the rate of deposition in pounds or in ounces per day or hour of any metal, or to measure other work done. When used with a Daniell cell (or several, as required), the indicator will point to the resistance of the circuit in ohms, and when used with a fixed resistance it will in like manner show at once the electromotive force of any battery used with it. It will thus do for many purposes, without other instruments, and without calculations, the work which at present requires the Wheatstone's Bridge and expensive resistance-coils as well as many calculations."

It is a pity that the book was not delayed in its publication so as to allow its readers to be gratified with a description of this combination of the admirable Crichton and the wonderful calculating boy.

Mr. Sprague is singularly unfortunate in his attack on electrical terms. With respect to quantity he says,—"As it is an evil to change terms once familiar, the term 'quantity' must still be used for this relation of energy to matter; but it cannot be too strongly fixed upon the mind that this word does not mean a *measure*, or the existence of a thing to be measured, but simply a *number* proportionate to the molecular chains in which is set up the condition illustrated in Section 29." (Induction).

Again, with respect to "potential:"—"Words whose meaning is indefinite are delusions, and as electromotive force and tension have definite meanings which the mind can grasp, those words are used here. The idea 'potential' is really meant to convey is one required only in the highest and most delicate branches of electrical science, and the word is best confined purely to its proper object."

The funny thing is that quantity *does* mean a measure, or the existence of a thing to be measured, and nothing else, and it is used in this sense throughout the book; and the word tension is very indefinite, for it is used by Mr. Sprague sometimes to express the constrained position of the molecules of matter under electrica influence, sometimes the amount of electrical energy present, sometimes the difference between the energy of two bodies, and in other senses. Thus he discards a term—*potential*—which has a perfectly definite meaning for one which is ambiguous and misleading, and which all our leading electricians have long since expelled from their vocabularies. However, in spite

of these peculiarities, the book contains a great deal of very useful and valuable matter, and it is one that will not only repay perusal but be useful for reference. The author has favoured us with many original communications, some of which have been embodied in this book; and we hope to continue to be the recipient of his remarks on his own special study.

Electrical Science in English and Foreign Journals.

Comptes Rendus Hebdomadaires des Seances de l'Academie des Sciences. Vol. lxxx., No. 5. February 1, 1875.

On Magnetism.—J. M. Gaugain.—*The Influence of Temperature on Magnetisation.* Mr. Elias mentions * a method of magnetising by heating the bar to redness, suspending it to the pole of an electro-magnet, and allowing it to cool in that position. He continues, "This method is without result." I do not know where the negative results which Mr. Elias mentions are to be found; but before reading his paper I tried to increase magnetism by the use of heat, and in certain instances I think I have succeeded. I first operated under the conditions indicated by Mr. Elias: small bars of steel, 4 to 8 m.m. in diameter were magnetised by putting one of their extremities for some moments in contact with one of the poles of a permanent magnet. I then determined their magnetic condition by ascertaining some points of their curve of demagnetisation; then they were again put in contact with the magnet, this time heating them by an alcohol lamp, and, when cold, were detached from the magnet. The magnetic condition being again determined, I found that the bars were much more strongly magnetised than before. In certain experiments the employment of heat doubled the value of the demagnetising currents. It must be remarked that the increase of magnetism referred to was only produced if the bar, after having been heated, remained in contact with the magnet whilst cooling. If, after the bar had been heated, and while yet warm, a separation took place, the magnetisation instead of being increased was diminished. In the foregoing experiment I occupied myself only with the permanent magnetism first received by the bar *after* separation from the magnet. It was interesting to find out in what manner heat modifies the *total* magnetism developed *during* contact of the bar and magnet. The total magnetisation was found considerably increased by heat; but it sufficed, in order to disperse a part of it, to separate (as before) the bar from the magnet for a few moments. These results appear interesting in so far as they justify the idea generally entertained respecting *coercive force.* This force, considered as a passive force analogous to friction, should retard the movement of the molecules in any direction in which this movement may be directed; and, admitting that coercive force decreases as temperature rises, we may expect that heat should favour magnetisation when the magnetising force gets the better of that coercive force which tends to restore the molecules to their position of equilibrium: on the contrary, heat should encourage demagnetisation when it is the molecular force which prevails over the magnetising force. It appears scarcely doubtful that the three forces just spoken of (magnetic, molecular, and coercive) do not all vary with temperature, but in my experiments the variations of the coercive force have most importance, and they are sufficient to explain the obtained results without requiring to estimate the variations of the other forces.

On Magnetism.—A. Trève.—If the two extremities of a large wire through which a current is passing are placed between the two poles of the large Ruhmkorff electro-magnet, neither spark nor noise is obtained on closing the circuit; but on opening it, a violent report, as loud as a pistol, is heard. Referring to this, Monsieur De la Rive said,—"It seems that the strength of the extra current may be powerfully increased in this case by the influence of the two poles of the magnet." This is the phenomenon now under discussion. Is it necessary to break the current in a position *between* the two poles to obtain this effect? No; if we withdraw from it one or the other of the two poles in order to study the polar action singly, we very soon find that,—1. The phenomenon is reproduced equally in the sphere of attraction of one or the other of these poles; 2. That it is not inherent in the single inducing current, but that the current of the whole battery broken in sphere of attraction, has a like effect; 3. That the extra current increases substantially and even considerably in tension. Oxygen being magnetic, it was desirous to know whether there is not some condensing or separating action on the constituent elements of the air in the magnetic field of the pole. Investigation has not revealed any such actions.

No. 6.

On the Magnetisation of Steels furnished with Armatures.—J. Jamin.—Continuing his paper (Telegraphic Journal, vol. iii., page 59), Monsieur Jamin now gives the results of some studies as to what takes place on re-magnetising the whole magnet with its armatures instead of without its armatures. The direction of his theoretical inquiries are based upon hypotheses enunciated in earlier papers, and cannot be intelligibly abstracted into this column in a small compass. It should be read in the original in conjunction with the previous papers.

Camacho's New Concentric Iron-tube Electro-magnet (See Telegraphic Journal, vol. ii., page 342).—To that notice we add the following abstract: "Experience shows that if we cover up the polar extremities of the tubes which constitute each core of the electro-magnet, by means of an iron shield or plate, the electro-magnet loses its great power and falls back into the conditions of an ordinary magnet. Indeed, the magnetism the shields take will have been developed by the influence of the polar extremities of all the tubes which will touch them; but these polar extremities cannot develop a greater magnetism than what they possess, and that simply upon the atoms of the shields which they touch; hence, the magnetism of the atoms of the exterior sides of the shield will be very weak. Moreover, as the free extremities of the tubes of each core have all the same magnetic pole, the union of them by the shield will produce the well-known weakening reactions attendant on the union of poles of the same name.'

Post-Office Telegraphs.—Statement showing the total number of messages forwarded from Postal Telegraph Stations in the United Kingdom during the week ended the 13th March, 1875, and during the corresponding week of 1874:—1875, 367,005; 1874, 335,400; increase in the week of 1875 on that of 1874, 31,605.—Week ended 20th March, 1875, and corresponding week of 1874:—1875, 389,003; 1874, 343,098; increase in the week of 1875 on that of 1874, 45,905.—Week ended 27th March, 1875, and corresponding week of 1874:—1875, 332,257; 1874, 359,542; decrease in the week of 1875 on that of 1874, 27,285. Easter has fallen earlier this year than in 1874, which accounts for the decrease shown.

* "Poggendorff's Annalen," vol. lxii., page 249.

To Correspondents.

J. S. J. (Falmouth.)—Declined with thanks. Our correspondent must acquire rhythm and rhyme before we can admit his poetic effusions into our columns.

Mr. David Brooks (Philadelphia).—We regret we cannot print your article except as an advertisement. It is full of errors as regards the practice and the condition of the lines in England.